REMARKS/ARGUMENTS

According to a feature of the invention set forth in the claims, a method for manufacturing a reduced metal includes steps of supplying fuel and primary combustion air to a reducing furnace on which a metal oxide including a carbonaceous reductant is disposed and reduced, and supplying secondary combustion air to the reducing furnace via a plurality of secondary burners. According to the invention, at least the secondary combustion air is oxygen enriched air, and the oxygen concentration in the primary combustion air is controlled to be lower than that in the secondary combustion air.

For example, referring to the non-limiting embodiments disclosed in the figures, pellets of a metal oxide and a carbonaceous reductant such as coal powder are mixed to form green pellets which are dried and fed to the hearth 2 of a reducing furnace 1. Primary burners 3 are provided with a fuel gas D and primary combustion air E, and secondary combustion burners 4 are provided with oxygen enriched air F. According to a feature of the invention, the oxygen concentration in the primary combustion air is controlled to be lower than that in the secondary combustion air. This reduces the amount of nitrogen oxides (NO_x) generated in the reducing furnace. This is because the primary burners 3 burn a higher calorific value fuel whose flame temperature would be excessive in the case of a high oxygen concentration (see specification, pages 11-12).

Claims 1 and 4-6 were again rejected as being obvious over Meissner '775 in view of Fuji et al '777, either alone or further in view of the newly cited U.S. patent 6,117,387 (Sarma et al). Both of these rejections are respectfully traversed.

Meissner et al was cited to teach a rotary hearth furnace for producing direct reduced iron from dried compacts of iron oxide and a carbonaceous material. Meissner et al describes that roof burners or wall mounted burners 52 are used to reduce the iron oxides in the compacts. The burners are supplied with oxygen enriched air. While additional preheated or

oxygen enriched air is supplied to burn volatiles and CO evolved from the compacts, Meissner et al also teaches that "efficient combustion is achieved due to the high operating temperature" (col. 6, lines 7-8). Indeed, Meissner et al explicitly endorses "operating with an oxidizing atmosphere at high temperature in the early stage of heating and reduction" (col. 6, lines 12-13) because it causes the volatiles to ignite on or near the surface of the dry compacts to form a radiant flame which enhances the heat transfer to the compacts. Meissner et al thus teaches against reducing the oxygen concentration in a primary combustion air since this would reduce the operating temperature in the early stage of heating.

Concerning Fuji et al, as explained in the last response, lines 23-31 of column 4 in Fuji et al disclose supplying a secondary combustion air to burn combustible gases released from the iron oxide agglomerates and carbonaceous material, but fail to disclose that at least the secondary combustion air is oxygen enriched air, or that the oxygen concentration of the primary combustion air is controlled to be lower than the oxygen concentration in the secondary combustion air. Fuji et al is therefore incapable of suggesting that the oxygen concentration in the primary combustion air in Meissner et al should be controlled to be lower than the oxygen concentration in the secondary combustion air.

The last paragraph of page 3 in the Office Action indicates that the limitation that the oxygen concentration in the primary combustion air should be controlled to be lower than that in the secondary combustion air simply represents the result of routine experimentation within the teachings of the art, to optimize productivity. However it is evident that this cannot be the case since it is contrary to the explicit teachings of Meissner et al that operating with an oxidizing atmosphere at high temperature in the early stage of heating and reduction is desirable because it causes the volatiles to ignite on or near the surface of the dry compacts to form a radiant flame which enhances the heat transfer to the compacts.

Applicants note that Sarma et al was cited to teach the use of oxygen enrichment for the secondary combustion burners of Meissner et al, and not for an oxygen concentration in the primary combustion air controlled to be lower than that in the secondary combustion air. Nonetheless, it is noted that Sarma et al cannot teach this missing feature because it teaches superstoichiometric ratios in the oxidizing zone 5, with elevated concentrations of oxygen in the oxidant, which would suggest high oxygen concentration in the primary combustion air of Meissner et al. This is the opposite of the claims, and so it is respectfully submitted that the claims define over any combination of the above references.

Claims 1-3 and 6 were also rejected under 35 U.S.C. § 103 as being obvious over U.S. patent 5,989,019 (Nishimura et al '019) in view of U.S. patent 6,296,479 (Nishimura et al '479) and U.S. patent 6,368,104 (Saxena et al). According to the Office Action, Nishimura et al '019 discloses a rotary hearth furnace in which the oxygen concentration in a primary combustion air is controlled to be lower than that in a secondary combustion air. This is respectfully traversed.

Nishimura et al '019 discloses a rotary hearth furnace including primary burners 4 and air feeders 6 which supply a secondary combustion air to a position where flammable gas is generated during the reduction of the metal oxide in the furnace. Nishimura et al '019 indicates that the primary burners 4 use air as an oxidizing agent (col. 3, line 14). However Nishimura et al '019 also indicates that the elements 6 which feed gas for secondary combustion also feed air. The elements 6 are universally referred to as "air feeders" which "feed air at a position where the flammable gas Ga is generated" (col. 4, lines 30-31). This indicates that air is fed to both the burners 4 and the elements 6, so that neither has a higher oxygen concentration.

Applicants note that the Office Action specifically refers to lines 1-2 of column 3 in Nishimura et al '019, which states that "examples of gas for secondary combustion used in

the present invention include air and oxygen-rich gas." It is presumably the position of the Office Action that the mention of "oxygen-rich gas" as the alternative gas for secondary combustion is a teaching of the use of a gas whose oxygen concentration is greater than air, so that Nishimura et al '019 presumably discloses that the oxygen concentration in the primary combustion air is lower than that in the secondary combustion gas. However, it is evident from a careful reading of the noted portion of Nishimura et al '019 that this is not the case. Lines 1-2 of column 3 in Nishimura et al '019 describe two alternatives for the secondary combustion gas. One is air and the other is an oxygen-rich "gas." However "oxygen-rich gas" does not inherently or necessarily mean a gas whose oxygen concentration is greater than air. Air itself is an oxygen-rich gas since it has a significant oxygen concentration. Thus lines 1-2 of column 3 in Nishimura et al '019 simply require that the secondary combustion gas have a significant concentration of oxygen, but not that the oxygen concentration is different from or greater than that of air.

Indeed, Nishimura et al '019 teaches against an excessive oxygen concentration for the secondary gas. Nishimura et al '019 describes that the secondary combustion gas may re-oxidize the reduced objects in case of a small amount of generated flammable gas (column 4, lines 59-61). A high oxygen concentration in the secondary combustion gas enhances this risk. Thus, to the extent that the "oxygen-rich gas" alternative of Nishimura et al '019 has an oxygen concentration different from air, this concern suggests that the oxygen concentration of the secondary gas should be *less than* that of air (the primary combustion gas) – the opposite of what is claimed.

Saxena et al was cited based upon the description at lines 1-15 of column 2 of this reference. Saxena et al discloses a rotary hearth furnace in which metal oxides are reduced. Lines 1-15 of column 2 describe that the combustion burners be provided with an excessive amount of oxygen so that the residual oxygen is available to combust the gases generated by

the reduction of the metal oxide. That is, the upstream burners 18a-18p which are upstream of the reducing zone 60 are provided with excess oxygen to create a lean combustion zone, whereas the downstream burners 18q-18d in the reduction zone function under a fuel rich atmosphere (col. 3, lines 25-41). Thus the teaching of Saxena et al. is also opposite to that of the claims: high oxygen concentrations for the upstream combustion and lower oxygen concentrations for the secondary combustion. Saxena et al is therefore incapable of overcoming the shortcomings of Nishimura et al '019.

Nishimura et al '479 was only cited to teach introducing secondary combustion air through a burner, and is also incapable of overcoming the shortcomings of Nishimura et al '019. The claims therefore define over any combination of the above references.

Concerning the rejections of the dependent Claims 2 and 3 as being obvious over Meissner et al in view of Fuji et al and Sarma et al, and further in view of Nishimura et al '479, since the Office Action indicates that Nishimura et al '479 does not disclose an oxygen concentration in the primary combustion air which is controlled to be lower than that of the secondary combustion air (see Office Action, page 5, lines 4-6), the additional reference to Nishimura et al '479 cannot overcome the shortcomings of Meissner et al in view of Fuji et al and Sarma et al as discussed above.

Similarly, with reference to the rejection of Claims 4 and 5 under 35 U.S.C. § 103 as being obvious over Nishimura et al '019 in view of Nishimura et al '479 and Saxena et al, and further in view of Fuji et al, since Fuji et al does not teach an oxygen concentration in a primary combustion air which is controlled to be lower than that in a secondary combustion air, the claims define over any combination of the above references.

Applicants therefore believe that the present application is in a condition for allowance and respectfully solicit an early notice of allowability.

Respectfully submitted,

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